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IMO: 9209221

Exhaust Gas Cleaning

EGC-System type: GTM-R10

Scrubber serial no: 0002/0003/0004/0005

Onboard Monitoring Manual (OMM)

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1 INTRODUCTION

This Onboard Monitoring Manual (OMM) provides a vessel's crew, Flag State representatives, and Class Surveyors the necessary detail for the process of onboard verification of the installed Exhaust Gas Cleaning System. It also provides the operating parameters to be measured and identification details of the associated sensors including the ranges to be used. It includes calibration method and maintenance for the sensors. The onboard verification procedure detailed in this manual becomes an additional form of onboard verification, along with other approved procedures, as detailed in the manufacturer's Engine Technical File. The use of Ship-CEMS (Direct Measurement and Monitoring Method) still requires the ship owner to maintain a Record Book of Engine Parameters to record any changes of SOx influencing components or engine performance settings.

1.1 General Requirements

This Onboard Monitoring Manual (OMM), has been designed to meet the requirements of the, MEPC.184(59) and contains the operating parameters measured and the identification details of the associated sensors including ranges to be used and precision of the sensors. It contains the verification and the calibration procedures to ensure the measured values are reliable and the system operates in safe and effective way.

Ship-CEMS measure the relevant engines' specific SO_2 (ppm) and CO_2 (vol %) emissions ratio. Signal is sent to the ships MAS system. Each engine uses onboard verification by the measurement and monitoring that records the SO_2 (ppm)/CO_2 (%) ratio. This SO_2 (ppm)/CO_2 (%) figure must be compared against the allowable limit, as given in AnnexVI Regulation 14. Test cycle data can be displayed through the CEMS Graphical User Interface (GUI). This data is securely stored on the ships MAS system. Ships MAS system compares this value against the applicable SO_2 (ppm)/CO_2 (%) emission limit, and gives an alarm for excess values.

The system must be fully maintained, serviced, and calibrated according to the requirements of the Ship-CEMS Operation and Maintenance Manual. Failure to keep appropriate maintenance or calibration records may result in failure of any survey or inspection. If the CEMS equipment fails, and it is not possible to repair the system within the allowable period, the vessel shall inform the Administration (Flag Authority) or Classification Society, the reason for failure and the remedial action planned to reinstate the system. The failure shall be recorded in the GTM-R10 Record Book.

The washwater discharge criteria are intended to act as initial guidance for implementing EGC system designs. The Criteria should be revised in the future as more data becomes available on the contents of the discharge and its effects, taking into account any advice given by GESAMP.

Administrations should therefore provide for collection of relevant data. To this end, ship-owners in conjunction with the EGC manufacturer are requested to sample and analyze samples of:

- inlet water (for background);
- water after the scrubber (but before any treatment system); and
- discharge water

This sampling could be made during approval testing or shortly after commissioning and at about twelve-month intervals for a period of two years of operation (minimum of three samples). Sampling guidance and analysis should be undertaken by laboratories using EPA or ISO test procedures for the following parameters:

- pH
- PAH and oil (detailed in GC-MS analysis)
- Nitrate
- Nitrite
- Cd
- Cu
- Ni
- Pb
- Zn
- As
- Cr
- V

The extent of laboratory testing may be varied or enhanced in the light of developing knowledge. When submitting sample data to the administration, information should also be included on washwater discharge flow rates, dilution of discharge, if applicable, and engine power should be included as well as specifications of the fuel used from the bunker delivery note as a minimum.

It is recommended that the ship that has provided this information to the satisfaction of the Administration should be granted a waiver for compliance of the existing installation(s) to possible future stricter washwater discharge standards. The Administration should forward information submitted on this issue to the Organization for dissemination by the appropriate mechanisms.

2 EXHAUST GAS MONITORING

2.1 Exhaust Gas Measurement System

The main purpose of the Continuous Emission Measurement System (Ship-CEMS) is to analyze Carbon dioxide and Sulphur dioxides in wet marine exhaust flue gas after the scrubber. The system configuration further provides for a straightforward user interaction, as ship crews seldom are familiar with in-line process analyzers, nor with system integration, validation and calibration procedures.

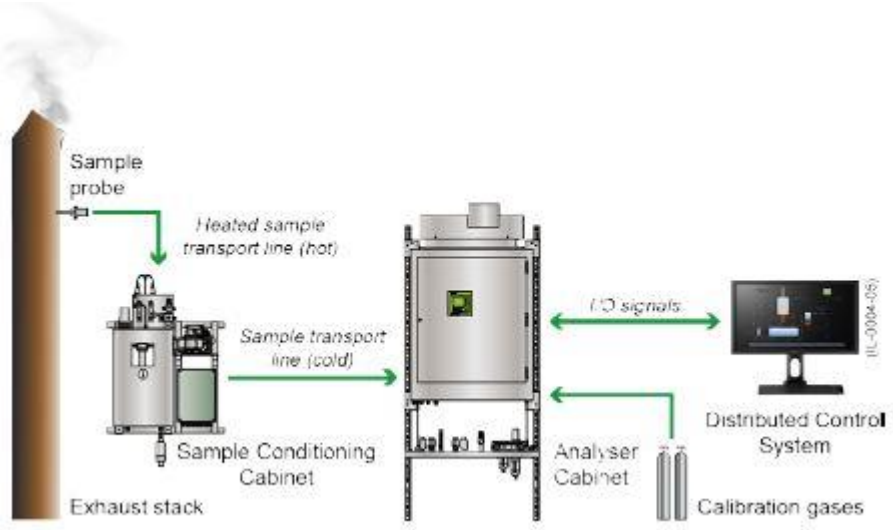

Figure 2-1: Ship-CEMS analyzer system

A heated sample probe is mounted after the Scrubber, in a section of straight exhaust duct, with a length of five diameters before and three diameters after an obstruction or bend.

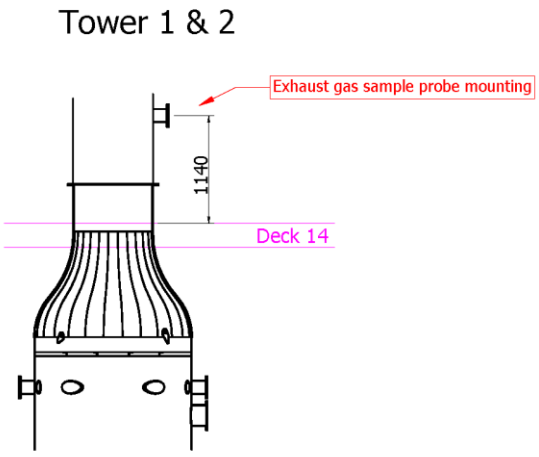

Figure 2-2: Position of sample probe, Scrubber Tower 1 & 2

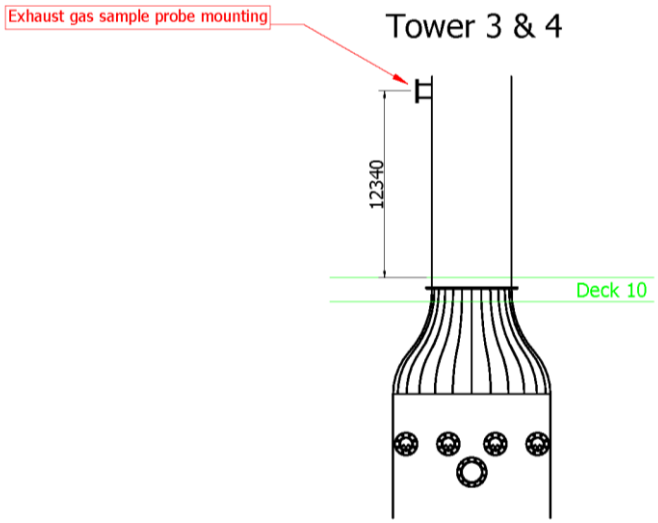

Figure 2-3: Position of sample probe, Scrubber Tower 3 & 4

The gas sample from the flue stack will now enter the Sample Conditioning System where it is filtered and passes through gas dryer tubes. After this the dried gas sample will enter the Analyzer System. For a multistack application, one of the stream-switching solenoids opens by the LOGO PLC to allow a sample to enter. The system handles measurements from four scrubbers (Ref. *Table 2-2: Ship-CEMS system specification).*

Needle valve NV-01 is used to set the sample flow to the analyzer to approximately 60 Nl/h. This can be monitored by flow meter Fl01. After being processed by the Ultramat 6 analyzer, the sample is released to ambient through the atmospheric vents.

The Analyzer Cabinet houses both the Ultramat 6 gas analyzer and the LOGO PLC controller unit. Both instruments are supported by a specially designed bracket inside the cabinet.

The Ship-CEMS system is designed for unmonitored, continuous operation, but both the Ultramat 6 and the LOGO PLC units may be manually operated.

Self-test diagnosis of analyzer maintenance, analyzer faults and so on are run periodically. If any test should fail, an error message is sent to the LOGO display and a hardwired alarm signal is sent to the customer. If a potentially harmful fault occurs, appropriate actions will automatically be taken, for example by shutting down the sample gas pump.

The Siemens Ultramat 6 unit is a single-channel analyzer used to measure gases whose absorption bands lie in the infrared wavelength range of SO_2 and CO_2. The analyzer operates according to the infrared two-beam alternating light principle with double-layer detector and optical coupler. The measuring principle is based on the molecule-specific absorption of bands of infrared radiation, as the absorbed wavelengths are characteristic to the individual gases. The detector layers will record the level of absorption, which then will be converted into an electric signal by a flow sensor. The values recorded are continuously presented to the customer's external control and monitoring systems by 4-20 mA analogue output signals for each gas component. Averaged values of SO_2 (ppm) and CO_2 (%vol) are sent to the tamper proof Data Recording Device. The exhaust gas analyzer Ultramat 6 (Version /MB2123-xNDxx-xCSx) has a Confirmation of Compliance (issued by GL 2014-07-03) and meets the following requirements:

- Principle of detection (MEPC. 184(59), 6.2)
- Accuracy (NTC 2008, Appendix III, 1.6)
- Precision (NTC 2008, Appendix III, 1.7)
- Noise (NTC 2008, Appendix III, 1.8)
- Zero and span drift (NTC 2008, Appendix III, 1.9 and 1.10)
- Calibration Curve (NTC 2008, Appendix IV, 5.5.1)
- Interference effect (NTC 2008, Appendix IV, 9)

Table 2-1: Ultramat 6 gas analyzer specification

Component	Sensor type	Smallest range	Highest range
SO_2	NDIR	0-50 ppm	0-1000 ppm
CO_2	NDIR	0-5%	0-15%

Table 2-2: Ship-CEMS system specification

SO_2/CO_2 measurement system		
System manufacturer	Norsk Analyse AS / Vimex AS	
Analyzer	SO_2	CO_2
Type designation	ShipCEMS by Vimex	
Max. measurement range	1000ppm	15%
Used measurement range	100[ppm]	10[%]
Output signal	DO + 4/20mA	
Ancillary equipment	Instrument air supply, calibration gas mixture	
Sampling probe	Buhler GAS 222.17 or 222.20 Heated single flange probe, length 500mm, SS316 or Hastelloy insertion tube, optional demister available	
Position of sampling probe	After the Scrubber, in a section of straight exhaust duct, with a length of five diameters before and three diameters after a bend	
Sampling line / In situ	Heated sample line 6/4mm PFA tubing between Heated sample probe and SCS, 4/6mm PFA tubing between SCS and Analyzer	
Exhaust gas pump	Not applicable, positive pressure vent to air	
Remarks		
Handling of water content of the exhaust gas to compensate for interference effects: The SCS removes the water to a very low dew point, no interference		
Analyzer measures alternating emissions after Scrubber 1, 2, 3, 4 **Measurement period per Scrubber:** 4 Scrubbers in operation: 40 sec / Scrubber 3 Scrubbers in operation: 65 sec / Scrubber 2 Scrubbers in operation: 110 sec / Scrubber 1 Scrubber in operation: Continuously Monitoring Data recording: within the minute of measurement (ref. ETM-B Manual, "Data Logger Diagram"). Rinse time / Switching time for sample gas: From solenoid valve in Analyzer cabinet, less than 30 s		
Sequential measurement of SO_2 and CO_2: difference app. NA (one single analyzer for SO_2 and CO_2)		

2.2 Calibration, Zero and Span Check Procedures

The instruments in the Analyzer Cabinet are operated and verified using front panel displays and control buttons. The display on the analyzer instruments are used for reading of real-time measurements and alarm conditions, and when running calibration procedures.

This chapter only describes how to use the control buttons to run maintenance and calibration procedures. However, menu-guided operation with plain text allows users and service personnel to operate the instruments in advanced modes. For more information, please refer to manufacturer's documentation (Drw. no.P2140-9-6-1).

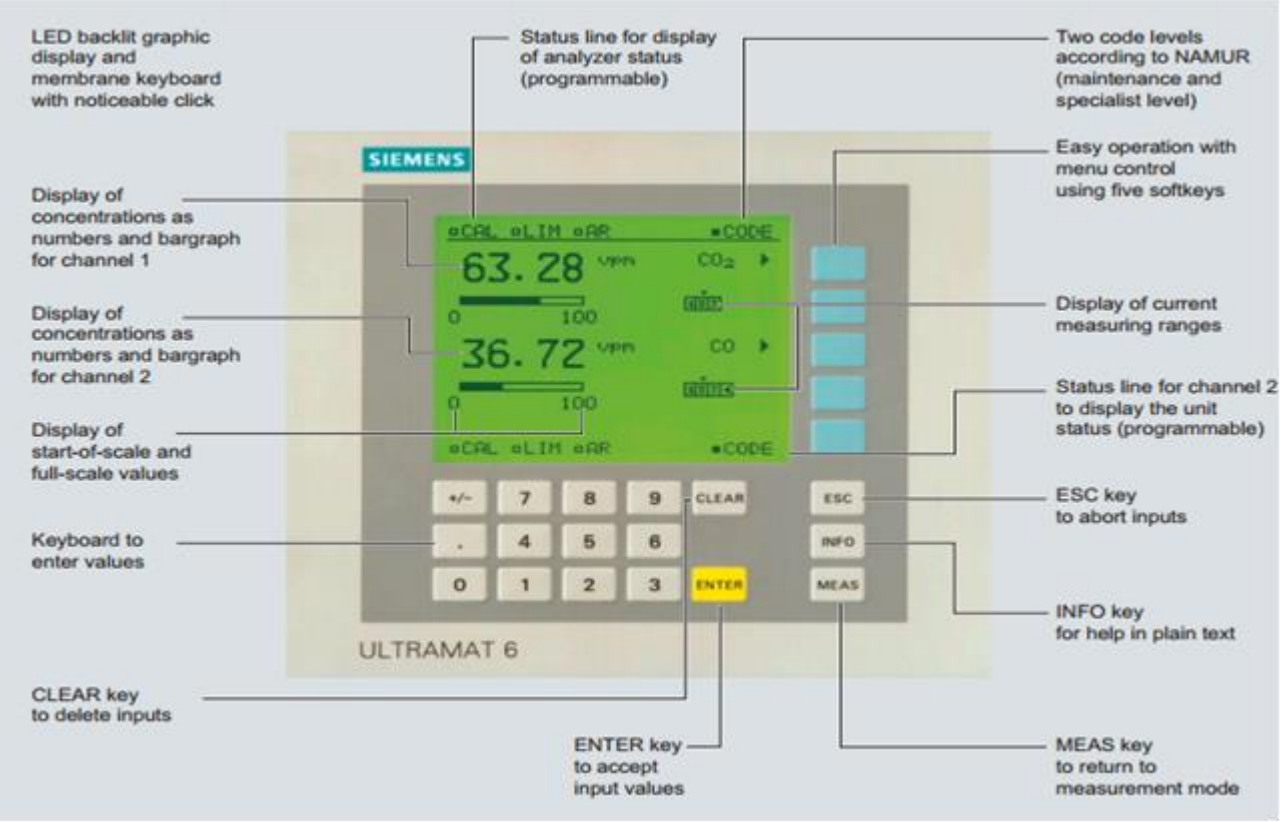

Figure 2-4: Siemens Ultramat 6 unit display

The Siemens LOGO PLC is a simple programmable logic controller for control of stream valves, validation and calibration valves, as well as for calibration of the analyzers. The unit will also warn if any alarm conditions occur, either via its local display – the LOGO TD - or remotely by hardwired signals.

Figure 2-5: Programmable logic controller for control of stream valves

The CEMS system allows various functions and viewing of data, as follows:

- Select each monitored engine and view instantaneous data
- View SO_2(ppm)/CO_2(%) Emission ratio
- Run Zero and Span
- View reports from the ship MAS system for the recorded data.

2.2.1 Automatic mode, self-test diagnosis

The Ship-CEMS system will run self-test diagnosis for the sample handling, analyzer state, and system maintenance and so on at periodic intervals. If any of these tests fails, an error message is sent to the LOGO TD display, whilst a hardwired alarm signal simultaneously is sent to the operator.

Sampling will only be possible when the sample inlet valve has been opened and none of the self-tests have failed for 30 seconds, signaling valid measurement.

2.2.2 Automatic mode, calibration

The Ship-CEMS system is designed to operate fully automatic and it will calibrate the Ultramat periodically based on the configuration done in the analyzer. Zero calibration is performed using clean, dry instrument air, while sensitivity (span) calibration must be done using certified calibration gas, as specified.

The analyzer will request what gas it needs and when it needs to calibrate. The request is sent to the LOGO PLC. Depending on the request, the appropriate solenoid valves are operated.

During automatic calibration the digital calibration signal is set high. This will notify the operator that calibration is running.

2.2.3 Manual mode

The LOGO unit holds four front panel control buttons F1 to F4 for manual operation.

F1: This button starts calibration of Ultramat IR channel 1. Make sure calibration gas is connected prior to starting this procedure.

F2: This button starts calibration of Ultramat IR channel 2. Make sure calibration gas is connected prior to starting this procedure.

F3: This button enters the menu for controlling the solenoids manually. This menu is used for troubleshooting and manual calibration of the system.

F4: This button is not used.

2.2.4 Pressure Transmitter

Pressure transmitters are used to monitor pressure in the Scrubber Tower. Pressure is a very important parameter for the safe operation of the system and therefore the transmitters have to be verified, by calibration. The pressure transmitters used in the Scrubber Tower have low measuring range since the pressure variation is small. Technical specifications are shown in the table below. *Ref. P2140-9-4-02 CTEM* for detail description.

Figure 2-6: Pressure Transmitter

Table 2-3: Technical Specification of Scrubber Towers Pressure Transmitters

Component	Specification	Description
Pressure Transmitter	Model No. (From Sensor Technics)	CTEM70025GY4 (Miniature pressure transmitter – Base accuracy: 0.5 %)
	Quantity (4 scrubbers)	8: (1PT3/1PT4/2PT3/2PT4/3PT3/3PT4/4PT3/4PT4)
	Span Limits	0 - 25 mbar
	Output	4 to 20 mA

2.2.5 Temperatur Transmitter

The temperature of the exhaust gas is measured continuously using temperature transmitters. The temperature transmitters can be verified with careful observation and comparison with the previous readings during the same condition. Technical specifications are shown in the table below. *Ref. P2140-9-4-01* for detail description.

Figure 2-7: Temperature Transmitter

Table 2-4: Technical Specification of Scrubber Towers Temperature Transmitters

Component	Specification	Description
Temperature Transmitter	Model No. (Pentronic)	5527152-021
	Quantity (4 Scrubbers)	8: (1TT1/1TT2/2TT1/2TT2/3TT1/3TT2/4TT1/4TT2)
	Thermowell Connection	ϕ10*200 Tapered thread G ¾''
	Measuring Insert Type	Resistance thermometer, extended measuring range PT100
	Sensor Accuracy	IEC 60751classA ($\Delta t = \pm (0.30 + 0.0050\|t\|)$)
	Transmitter Measuring Range	-50 to +600 °C
	Material	Hastelloy

2.2.6 Level Switches

High washwater level alarm switches are installed in the Scrubber Towers to avoid overflow of washwater down to the engines. The level switches will activate emergency stop of the system and stop the pumps. In each Scrubber Tower; one level switch is installed in the upper chamber and two level switches are installed in the lower chamber. Technical specifications are shown in the table below. *Ref. P2140-9-4-03 Level Switches* for detail description.

Figure 2-8: Emerson High Level Alarm Switch

Table 2-5: Technical Specification of Emerson High Level Alarm Switches

Component	Specification	Description
High Level switch	Model No.(Emerson)	2130DA2EH1NNBA00001NA
	Quantity	8: (1HLS1/1HLS2/2HLS1/2HLS2/ 3HLS1/3HLS2/4HLS1/4HLS2)
	Measuring Type	Enhanced Vibrating Fork Liquid Level Switch
	Material housing Construction material	Aluminum Hastelloy
	Out put	2 change-over contacts
	Operating temperature	-70-260^{o}C
	Process connection size	25mm

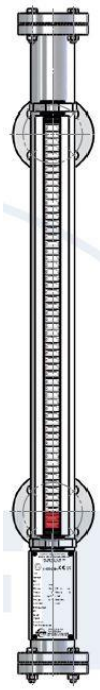

Figure 2-9: Kübler High Level Alarm Switch

Table 2-6: Technical specification of Kübler High Level Alarm Switches

Component	Specification	Description
High Level switch	Model No.(Kübler)	BNA-FA-1/150/RF-M200-VEEC/63/2.00-2/RU60/3/SIL-ZVEECSSA/300/B152
	Quantity	4: (1HLS3/2HLS3/3HLS3/4HLS4)
	Measuring Type	Bypass float type with external level switches
	Material	ECTFE (Halar) Coated 316L Stainless steel
	Mounting	1''
	Guide tube length	25mm
	Output	2 change over contact

2.3 Maintenance of Ship-CEMS system

Ship-CEMS is designed to require minimal routine maintenance. The following maintenance schedule is recommended to be performed by operators. Ref. *P2140-9-6-01 CEMS User Manual* for the detailed procedure for the maintenance.

2.3.1 Daily Maintenance

Unit	Remarks
Heated sample line	- Check temperature by hand - Sample tube should be noticeably warm at cabinet intake
All instruments	- Check instrument displays for fault messages

2.3.2 Weakly maintenance

Unit	Remarks
Cabinet and unit exterior	- Clean all surfaces
Air conditioning unit	- Check that air inlet and outlet vents are free from sand, dust or other foreign matters
Ultramat instrument	- Check flow (approximately 1 l/min)

2.3.3 Monthly maintenance

Unit	Remarks
Calibration	- Perform calibration monthly - Intervals may be reduced if the deviation between each control increases - Intervals may also be extended if the deviation is insignificant
Sample line inside cabinet	- Check all tubing visually for condensation
Sample probe filter	- Check for contamination and physical damage - Clean or replace as required

2.3.4 Six-Months Maintenance

Unit	Remarks
Sample probe filter	- Replace filter - May be replaced earlier if flow is reduced to such a level that alarms are active

2.3.5 Yearly Maintenance

Unit	Remarks
Heated sample line	- Check for moisture and contaminations - Clean as required
Gas pump membrane	- Check physical condition - Replace if required
Sample probe filter	- Check for contamination and physical damage - Clean or replace as required

2.3.6 Maintenance after 3 years

Unit	Remarks
Gas pump membrane	- Replace every three years

3 WASHWATER MONITORING

The water monitoring system is installed in one of the inlet washwater line (P), and both of the discharge washwater lines (SB and P). The discharge washwater quality from the Scrubber is measured before any dilution. The inlet and discharge washwater measurement system is denoted as TPP. TPP measures the water quality parameters: Turbidity, PAH and pH. Turbidity and PAH measurement cabinet is shown in figure 3-1, and the pH sensor is directly inserted into both of the washwater inlets (SB and P) and both of the discharge pipes (SB and P).

Figure 3-1: Turbidity and PAH measurement cabinet for the washwater monitoring system

3.1 PAH Sensor

Fluorescence is a sensitive method to determine Polycyclic Aromatic Hydrocarbon compounds in water. Fluorescence in general is a phenomenon, whereby a portion of the absorbed wavelength is re-emitted by the targeted compound at higher wavelength. When the water is excited at specific wavelength, certain compounds, including hydrocarbons, will absorb energy and will re-emit this light. The wavelength range which is re-emitted is a unique characteristic of the single compound. By measuring the fluorescence intensity at these wavelengths, they can be determined.

Table 3-1: Technical specification for PAH sensor

PAH Sensors		
Position	Inlet open loop	Outlet open loop
Sensor ID	10PAH1	11PAH1 / 11PAH2
Manufacturer	Turner Designs Hydrocarbon Instruments	
Type designation	TD-5100ECA Scrubber Washwater Monitor	
Measurement principle	Fluorescence	
Measurement range	0-100 µg/L (preset)	
Output signal	Analogue: 4-20 mA, 24V	
Turbidity correction	In accordance with MEPC.184(59), Washwater Monitoring 10.2.3	
Data processing	Optional	
Calibration	Factory calibrated, no adjustments required A check solution standard, PN 105420, is supplied with the monitor. The Home screen should display 50 ppb when the standard is injected.	
Maintenance	Ref.: Maintenance of Washwater Monitoring System	

3.2 Turbidity Sensor

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particles. The more total suspended solids in the water, the hazier it becomes and the higher the turbidity.

Table 3-2: Technical specification for Turbidity sensor

Turbidity Sensors		
Position	Inlet open loop	Outlet open loop
Sensor ID	10TU1	11TU1 / 11TU2
Manufacturer	Turner Designs Hydrocarbon Instruments	
Type designation	TD-5100ECA Scrubber Washwater Monitor	
Measurement principle	In accordance with ISO 7027:1999	
Measurement range	0-100 NTU	
Output signal	Analogue: 4-20 mA, 24V	
Data processing	Optional	
Calibration	Factory calibrated, no adjustments required	
Maintenance	Ref.: Maintenance of Washwater Monitoring System	

3.3 pH Sensor

pH can be described as a measurement of the concentration of hydrogen ions. The pH sensor has field replaceable pH electrode for the determination of hydrogen ion concentration.

Figure 3-2: pH sensor, pH electrode, wet- tap installation

Table 3-3: Technical specification for pH sensor

pH Sensors		
Position	Inlet open loop	Outlet open loop
Sensor ID	10PH1 /10PH2	11PH1 / 11PH2
Manufacturer	George Fischer	George Fischer
Type designation	GF pH ORP 2750	GF pH ORP 2750
Measurement principle	Ag/AgCl reference electrode Automatic temperature compensation	Ag/AgCl reference electrode Automatic temperature compensation
Measurement range	0 to 14 pH	0 to 14 pH
Resolution	≤ 0.01 pH	≤ 0.01 pH
Output signal	4-20 mA, 12 to 24 VDC	4-20 mA, 12 to 24 VDC
Data processing	Optional	
Calibration	Ref. 3.3.1 Operation and Calibration	
Maintenance	Ref.: Maintenance of Washwater Monitoring System	

3.3.1 pH Sensor Operation and Calibration

The sensor-probe is a combination electrode consisting of a proton selective glass reservoir filled with buffer at approximately pH 7 and an Ag/AgCl reference electrode that utilizes electrolyte that is gelled. Protons (H+ ions) on both sides of the glass (media and buffer reservoir) selectively interact with the glass, setting up a potential gradient across the glass membrane. Since the hydrogen ion concentration in the internal buffer solution is invariant, this potential difference, determined relative to the Ag/AgCl reference electrode, is proportional to the pH of the media.

- When filling the calibration cup prior to performing the calibration procedure, make certain that the level of calibration buffers is high enough in the calibration/storage cup to cover at least ½ inch of the pH probe.
- Rinse the sensors with deionized water between changes of calibration buffer solutions.
- During pH calibration, allow the sensors time to stabilize with regard to temperature (approximately 60 seconds) before proceeding with the calibration protocol. The pH readings after calibration are only as good as the calibration itself.
- The true pH values of commercially-available buffers are slightly temperature dependent with the actual pH values at various temperatures usually shown on the bottle. For example, the actual "pH 7 buffer" at 20 ºC is 7.02 rather than the value of 7.00 at 25 ºC. Users who wish to obtain the maximum accuracy from their pH sensors should first determine the temperature of their buffers and then enter the proper pH reading for that temperature (from the bottle label) when carrying out calibration of pH.

3.4 Flow Sensor

The Signet 3519 Flow Wet-Tap Valve has unique interface between the installation fitting and the wet tap style Signet 515 or 2536 Rotor-X flow sensor. It provides a fast method of removing the sensor from the pipe when the system is shut down and depressurized. The Signet 3519 Wet-Tap Valve mounts directly onto standard Signet installation fittings. The 3519 Wet-Tap consists of a flange and support plate that threads onto the pipe fitting insert, and a PVC ball valve through which an extended length sensor is inserted into the pipe. Technical specifications of the flow meter are shown in the table below. *Ref. P2140-9-4-04 Flow sensors* for detail description.

Figure 3-3: Flow sensor with wet- tap installation, extended length flow sensor

Table 3-4: Technical specification for the flow sensor

Component	Specification	Description
Flow Sensor	Model No. (From GF)	Signet 515 Rotor-X Paddlewheel Flow Sensors
	Quantity	6nos.(1FT1/2FT1/3FT1/4FT1/11FT1/11FT2)
	Measuring range Operating temperature and pressure Accuracy	0.3-6 m/s&DN15-DN900 7 bar max. @ 20 °C 1.4 bar max. @ 66 °C ±1% of measured value*
	Connection (Wetted Parts) O-rings Rotor Pin Rotor	Glass-filled PP (black) or PVDF (natural) FPM (std), optional EPR (EPDM) or FFPM Titanium, Hastelloy-C or PVDF; optional Ceramic, Tantalum, or Stainless Steel Black PVDF or Natural PVDF; optional ETFE, with or without carbon fiber reinforced PTFE sleeve
	Output	4 to 20 mA

3.5 Pressure Transmitters

Pressure transmitters are used to monitor pressure inside the washwater pipelines for the safety and control of the washwater system. Technical specifications are shown in the tables below.

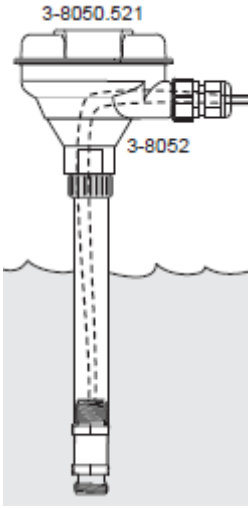

Figure 3-4: Pressure Transmitters in Washwater Pipes

Table 3-5: Technical Specification of the Pressure Transmitters in Washwater Pressure Pipes

Component	Specification	Description
Pressure Transmitter	Model No. (From George Fisher)	GF Signet 2450
	Quantity	8: (1PT1/1PT2/2PT1/2PT2/3PT1/3PT2/4PT1/4PT2)
	Span Limits	0.3-4bar
	Pressure Connection	1/2 in. Union male thread
	Wetted material	• Sensor housing: PVDF • Diaphragm: Ceramic • Seal: FPM

Table 3-6: Technical Specification of the Pressure Transmitters in Washwater (sea) Inlet Pipes

Component	Specification	Description
Pressure Transmitter	Model No.(From George Fisher)	GF Signet 2450
	Quantity	2: (10PT1/10PT2)
	Span Limits	0.41-3.4bar
	Wetted material	• Sensor housing: PVDF • Diaphragm: Ceramic • Seal: FPM

3.6 Temperature Transmitter

The temperature of the washwater is measured continuously using temperature transmitters. The temperature transmitters can be verified with careful observation and comparison with the previous readings during the same condition. Technical specifications are shown in the table below. *Ref. P2140-9-4-01* for detail description.

Figure 3-5: Temperature Transmitter

Table 3-7: Technical Specification of the Washwater Temperature Transmitters

Component	Specification	Description
Temperature Transmitter	Model No. (Pentronic)	5527152-001
	Quantity	6: (10TT1/10TT2/1TT3/2TT3/3TT3/4TT3)
	Thermowell Connection	ϕ10*150 Tapered thread G ½''
	Measuring Insert Type	Resistance thermometer, extended measuring range PT100
	Sensor Accuracy	IEC 60751classA ($\Delta t = \pm (0.30 + 0.0050\|t\|)$)
	Transmitter Measuring Range	-50 to +600 °C
	Material	Hastelloy

3.7 Maintenance of Washwater Monitoring system

General maintenance is described below. For detailed instructions about Turbidity and PAH sensors, follow the maintenance instructions in the P2140-9-5-01 Manual.

3.7.1 Weekly Maintenance

Description	Routine
Turbidity and PAH: Confirm the flow rate	- The sample flow should be maintained at about 1 L/min.
Turbidity and PAH: Make sure the flow cell is clean	- Make adjustments to the automatic cleaning parameters, such as increasing the frequency or duration of cleanings, or clean the fuel cell manually.
Turbidity and PAH: Confirm calibration	- Purge the sample stream by injecting DI water via the Luer-Lok® port, and then inject the check solution.
Turbidity and PAH: Inspect all tubing and piping connections	- Replace / tighten as necessary
pH: Ensure instrument operates well	- Calibrate if necessary

3.7.2 Six-Months Maintenance

Description	Routine
Turbidity and PAH: Clean flow cell with cleaning solution	- Refer to P2140-9-5-01 Manual
Turbidity and PAH: Confirm calibration	- Refer to P2140-9-5-01 Manual
pH: Ensure the instrument operates well	- Replace and calibrate if found defective

3.7.3 Two-Year Maintenance

Description	Routine
Turbidity and PAH: Replace ultrasonic probe	- Refer to P2140-9-5-01 Manual
Turbidity and PAH: Replace Luer-Lok® syringe port	- Refer to P2140-9-5-01 Manual
pH: Sensor	- Replace and calibrate

4 TROUBLE SHOOTING

Problem	Possible Causes	Solutions
Ship-CEMS	• Electrical circuit breakdown. • Sensor probe not working properly • Probe filter clogged • System not programmed properly • System not calibrated properly	• Repair it • Clean it with a clean soft cloth or replace it • Clean the filter or replace it • Check the program and modify it. • Recalibrate it
Turbidity and PAH	• Electrical circuit breakdown • Sensor probe contaminated with the oil or biofilm formed in the probe • No proper sensor cleaning system • Sensors are not working	• Repair it • Clean it, if it still does not work replace it and perform check solution • Arrange proper cleaning system, as suggested by supplier. Do periodic maintenance • Consult with the supplier and replace it, if it's not possible to repair.
Pressure/Flow/ Temperature/ Level -sensor(s)	• Probes contaminated or broken	• If a sensor is showing unusual values with the same operating conditions; repair or replace it with a new one.
pH sensor not working properly	• System not programmed properly • pH sensor located on probe has dried out due to lack of moisture • pH sensor located on probe has biofilm and oil contamination	• Check the program properly • Maintain the liquid level to avoid dry in the probe • Clean or replace it • It is recommended that back-up probes are maintained

5 SURVEY OF THE MONITORING OF THE EGC SYSTEM

A periodical survey onboard by the Administration or Port State Authorities to check the monitoring system of both exhaust gas and washwater can be performed according to following checklist:

- Check that MARPOL documents are onboard; SECP, ETM Scheme B, OMM and Electronic Logging System.
- Check that the Electronic Logging System has been recording data according to MEPC. 184(59) sections 4.4.7, 5.4.2 and 10.3, against UTC and ships position.
- Check that the GTM-R10 Record Book has been filled out properly during operation of the vessel/EGC system (Ref. Appendix D).
- Check the instruments calibration validity and functionality.
- Check the nitrate discharge data (ref. MEPC.184(59) 10.1.5.2)

6 APENDICES

Appendix A1: GTM-R10 Test Cycles

GTM-R10 Serial Number:	0002
Vessel Name:	Pride of America
IMO Number	9209221
Engine Number	91220

Engine Load	Max possible(--MW)	75%(6.3MW)	50%(4.2MW)	25%(2.1MW)
Sulfur content in the fuel (%)				
SO_2(ppm)/CO_2(%) (after scrubber)				
ΔPAH(μg/L)				
ΔTurbidity(NTU)				
pH (4m away from the ship side)				
ΔTemperature				
Inlet Pressure				
Inlet Flow				

Appendix A2: GTM-R10 Test Cycles

GTM-R10 Serial Number:	0003
Vessel Name:	Pride of America
IMO Number	9209221
Engine Number	91221

Engine Load	Max possible(--MW)	75%(6.3MW)	50%(4.2MW)	25%(2.1MW)
Sulfur content in the fuel (%)				
SO_2(ppm)/CO_2(%) (after scrubber)				
ΔPAH(μg/L)				
ΔTurbidity(NTU)				
pH (4m away from the ship side)				
ΔTemperature				
Inlet Pressure				
Inlet Flow				

Appendix A3: GTM-R10 Test Cycles

GTM-R10 Serial Number:	0004
Vessel Name:	Pride of America
IMO Number	9209221
Engine Number	91222

Engine Load	Max possible(--MW)	75%(6.3MW)	50%(4.2MW)	25%(2.1MW)
Sulfur content in the fuel (%)				
SO_2(ppm)/CO_2(%) (after scrubber)				
ΔPAH(μg/L)				
ΔTurbidity(NTU)				
pH (4m away from the ship side)				
ΔTemperature				
Inlet Pressure				
Inlet Flow				

Appendix A4: GTM-R10 Test Cycles

GTM-R10 Serial Number:	0005
Vessel Name:	Pride of America
IMO Number	9209221
Engine Number	91223

Engine Load	Max possible(-- MW)	75%(6.3MW)	50%(4.2MW)	25%(2.1MW)
Sulfur content in the fuel (%)				
SO_2(ppm)/CO_2(%) (after scrubber)				
ΔPAH(μg/L)				
ΔTurbidity(NTU)				
pH (4m away from the ship side)				
ΔTemperature				
Inlet Pressure				
Inlet Flow				

Appendix B: Commissioning Certificate

REFER TO SCANNED COPY

GTM-R10 Commissioning Report

GTM-R10 Serial Number _____

Vessel Name Pride of America

IMO Number 9209221

Date of Commissioning _____

	Date	Engineer signature/Stamp
GTM-R10 operation		
Process Control system		
Emsys System		
Washwater Monitoring system		

Vessel Authorized

Signatory Name _____

Signature _____

Commissioning Engineer _____

Date _____

Appendix C: Initial SO_2(ppm) / CO_2(%) Data

Engine Name	Measured SO_2(ppm)/CO_2(%) ratio	Compliance Limit	Engine Load	Date of the test
Main Engine 1		4.3		
Main Engine 2		4.3		
Main Engine 3		4.3		
Main Engine 4		4.3		

Vessel Authorized

Signatory Name _____

Signature _____

Commissioning Engineer _____

Date _____

Appendix D: Calibration Requirements

SN	Item	Permissible deviation (± absolute value)	Calibration Intervals(months)
1	Ship CEMS system	±1%	1
2	PAH Sensor	ref. Table 3-1	-
3	Turbidity Sensor	ref. Table 3-2	-
4	pH Sensor	±0.1	1
5	Flow Sensor	±2%	During commissioning
6	Pressure Transmitter	±0.1%	During commissioning
7	Temperature Transmitter	±1°C	never
8	Level Switches	±1%	During commissioning

Appendix E - List of Acronyms and Abbreviations

Acronym	Full Form	
CEMS	*Continuous Emissions Monitoring System*	
CO_2	*Carbon dioxide*	
ECAs	*Emission Control Areas*	
EGC	*Exhaust Gas Cleaning*	
EGCS	*Exhaust Gas Cleaning Systems*	
ETM-B	*EGC system – Technical Manual for Scheme B*	
HFO	*Heavy Fuel Oil*	
HLCU	*Heated Line Control Unit*	
IMO	*International Maritime Organization*	
IR	*Infrared*	
MARPOL		*International Convention for the Prevention of Pollution from Ships*
MGO	*Marine Gas Oil*	*Light, refined diesel fuel with a sulfur content of 0.5% or less*
OMM	*Onboard Monitoring Manual*	
PAH	*Polycyclic Aromatic Hydrocarbons*	
pH	*power of the concentration of hydrogen ions*	
PLC	*Programmable Logic Controller*	
PM	*Particulate Matter*	
SCU	*Sensor Control Unit*	
SO_2	*Sulphur dioxide*	
SO_X	*Sulphur oxides*	
TPP	*Turbidity, PAH, pH*	
UPS	*Uninterruptable Power Supply*	
UTC	*Universal Time Coordinated*	
MC	*Manual Control*	
RC	*Remote Control*	

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